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A COMPUTERIZED APPROACH TO THE INDIVIDUALIZING OF INSTRUCTIONAL EXPERIENCES.

BY- NACHTIGAL, PAUL
BOULDER VALLEY PUBLIC SCHOOLS, COLO.

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A CONCEPTUAL MODEL OF THE TEACHING-LEARNING PROCESS USES A SYSTEMS APPROACH TO ALLOW COMPUTER ANALYSIS OF THE INTERACTION OF THE VARIABLES. THE PROCESS INCLUDES A TEACHING-LEARNING ENVIRONMENT, COMPOSED OF VARIABLES IN A CURRICULUM MODULE, THE INDIVIDUAL LEARNER AND HIS CHARACTERISTIC VARIABLES, AND INTERACTION OF THESE TWO THROUGH A TEACHING-LEARNING CYCLE. ONE SYSTEMS ORGANIZER, OR STATEMENT OF EDUCATIONAL GOALS, CORRESPONDS TO EACH MODULE AND TO A CURRICULUM MAP THAT LOCATES THE MODULE ACCORDING TO SEQUENCE OF DIFFICULTY AND LEVEL OF LEARNING. EACH MODULE CONSISTS OF VARIABLES RELATING TO A SPECIFIC BEHAVIORAL OBJECTIVE, THE LEARNING CONTENT, AND THE LEARNING PROCESS. MODULES PROVIDE INFORMATION USED TO MAKE DECISIONS REGARDING THE LEARNER AND HIS ENVIRONMENT. THE TEACHING-LEARNING CYCLE PROVIDES THE FRAMEWORK FOR IMPLEMENTATION OF THE DECISIONS. TEACHERS USE 2 COMPUTER DATA-FILES OF CURRICULUM MODULES AND INDIVIDUAL STUDENT CHARACTERISTICS TO MAKE INSTRUCTIONAL DECISIONS. IMPLEMENTATION OF THE MODEL WILL REQUIRE RESTRUCTURING OF THE CURRICULUM BY A TEAM OF EDUCATORS, AND INSERVICE TEACHER TRAINING. THE TEACHER'S NEW ROLE WILL BE AS TUTOR AND CONSULTANT ON LEARNING ACTIVITIES. AN ELEMENTARY SCHOOL LANGUAGE ARTS CURRICULUM IS THE FOCUS OF A PILOT PROJECT FOR THIS MODEL. (LH)

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A COMPUTERIZED APPROACH TO THE INDIVIDUALIZING OF INSTRUCTIONAL EXPERIENCES

Boulder Valley School District Re2

Director - Paul Nachtigal

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NATURE OF PROBLEM

Each year research adds to the reservoir of knowledge in the field of education. This knowledge relates to curriculum, the way learning takes place, the nature of individual students as well as individual teachers. Sound decisions concerning specific learning experiences for individual students become increasingly difficult as this body of knowledge increases. For the most part instructional decisions are presently made by an individual teacher based on his own previous experience and his ability to recall. Because of human limitations the amount of information used in making these decisions is fairly constant and relatively small.

We now have available a means for expanding our capacity to use this ever increasing reservoir of information in the field of education through the use of computers. Here is a tool which can rapidly and tirelessly sort, categorize, search for, retrieve, and display information.

It is the intent of this project to use this tool to make available in an organized fashion appropriate information for designing programs for individual learners. It is recognized that the first attempts to integrate the computer into the decision making process in the classroom may be somewhat gross. However, it is anticipated that as experience is gained and additional research findings are fed into the system, the alternatives presented and the decisions reached will become more highly differentiated.

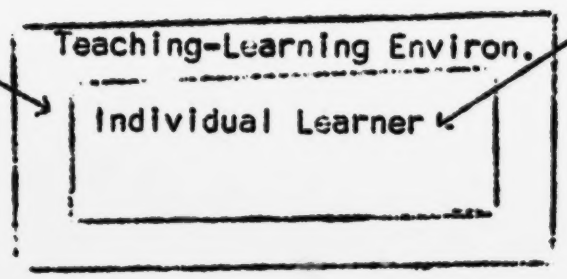
Appendix A

A SYSTEMS APPROACH TO THE TEACHING-LEARNING PROCESS

"A Conceptual Model"

The teaching-learning process is a very complex set of interactions between the individual student and his learning environment. This process might be described as the interaction of two dynamic systems, one system representing the learner the other system representing the teaching-learning environment with which he interacts.

The teaching-learning environment is a composite of T-L variables which include objectives, learning content, learning process, etc.



The individual learner is a composite of variables, many of which can be identified and quantified.

These variables can be controlled to provide learning alternatives which are tailored to more nearly match the individual learner variables

These variables, with few exceptions continue to be modified as a result of growth and experience.

This conceptual model has been developed which will (1) accomodate the component parts of the two systems and their interaction which constitute the teaching-learning process, and (2) allow the use of the computer to assist with the decision making process of the instructional program. The component parts are each broken down into the smallest segment or "module" that can stand alone and be dealt with in some relationship to the other "modules" of the system.

It is this building block approach to the teaching-learning process which will allow the flexibility to structure programs for individual students.

THE BUILDING BLOCKS OF THE TEACHING-LEARNING PROCESS

The component parts of the teaching-learning environment will include the variables relating to behavioral objectives, learning content, and learning processes. The building block of this system will be the "curriculum module".

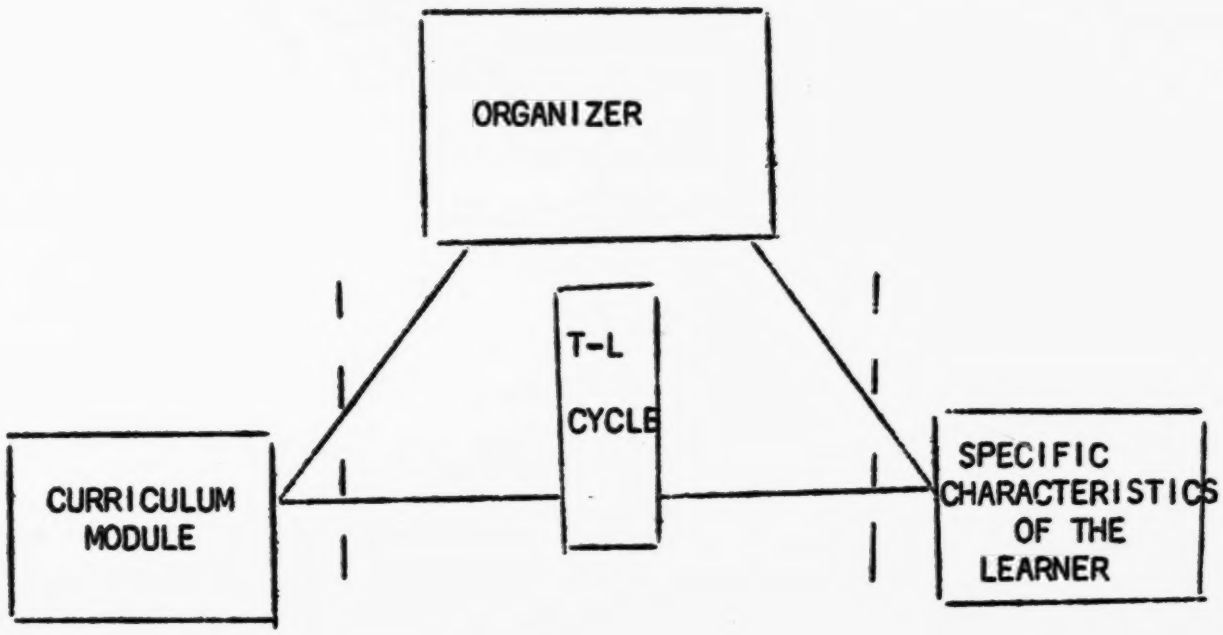
The system representing the individual learner will accomodate the variables of interest, ability, learning style, achievement etc. The building block of this system will be the "specific characteristics of the learner".

The interaction of these two systems will be the third element considered in the conceptual model. The building block of this interaction is the "teaching-learning cycle". We have then as the basic unit of the system, the specific characteristics of the learner interacting with a curriculum module through a teaching-learning cycle.

The focus for the two systems and their interaction is provided by a series of systems "organizers". These organizers are statements of expected outcomes or broad general goals of education. Such a statement of goals can be found in the publication Goals for Education in Colorado.[4] The organizers for this project will be derived from this and other similar publications

The relationships between the above elements of the model are diagramed on the following page.

[4] Goals for Education in Colorado, Colorado State Department of Education:1962



SYSTEM OF T-L ENVIRONMENT

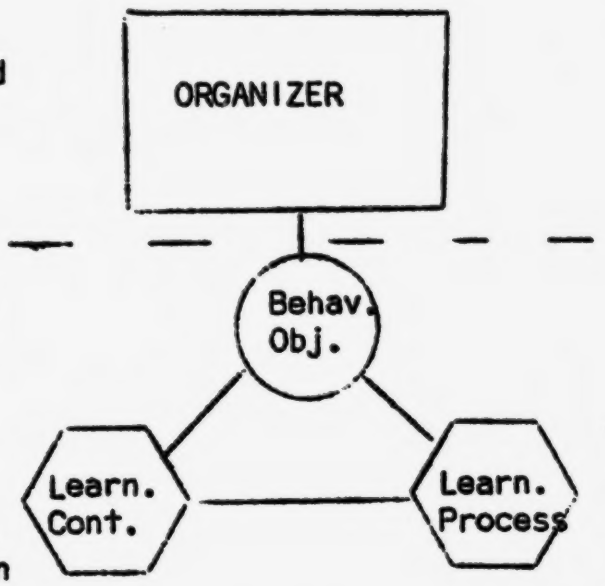
The curriculum module will provide the T-L alternatives of the instructional program. This module consists of (1) a specific behavioral objective, (2) the learning content, and (3) the learning process which will facilitate the acquiring of the behavior specified in the objective.

It is this information about teaching-learning alternatives which will be used in making the instructional decisions for individual students. The structure of this module and its relationship to the system organizer is as follows:

The curriculum will be structured around organizers 1, 2, . . . n

Relating to each of the organizers will be a number of specific behavioral objectives 1, 2, . . . n

For each behavioral objective there will be (a) various learning content alternatives 1,2, . . n and (b) various learning process alternatives 1, 2, . .n



Each combination of a behavioral objective, learning content, and learning process will constitute a curriculum module.

Behavioral Objectives

The specific behavioral objectives would define those concepts, skills, knowledges etc. that must be acquired by an individual as a step toward the attainment of the general objective as stated in the organizer. The specific behavioral objective must spell out:

(1) What it is the individual must be able to do, i.e. what behavior the individual is able to perform if he has achieved the objective.

(2) Under what conditions the individual will be able to perform the desired behavior.

(3) To what extent the individual will be able to perform the desired behavior.[5]

There will be a great number of behavioral objectives which will relate to the organizer. Some will be sequential in nature some will not. It is important that the relationship of one specific objective to another be clearly identified, and a curriculum map (see page 7) developed which will show this relationship between the objectives.

In moving through the sequence of behavioral objectives the individual will need to show evidence of having achieved the desired behaviors and not necessarily proceed step by step through the curriculum modules.

Content Variables

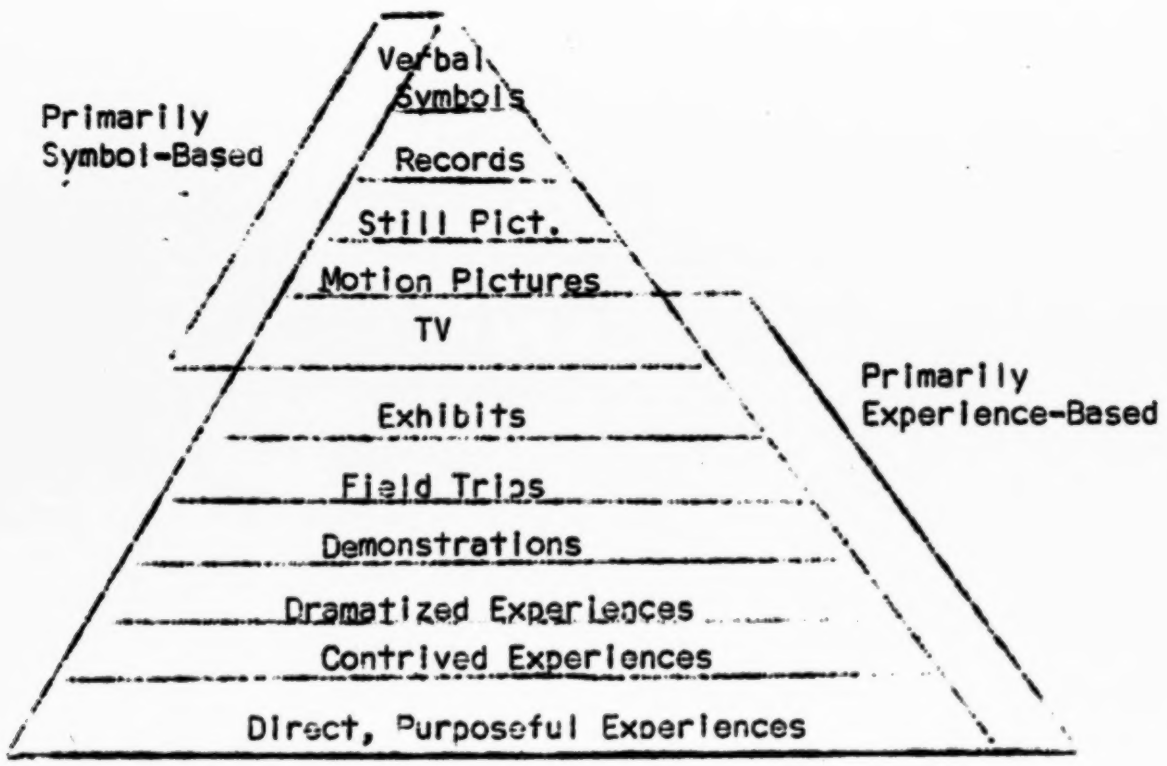
Adequately defined behavioral objectives will allow the use of a variety of learning content. No longer must all children read the same stories in order to achieve the skills of reading. Alternatives in learning content will make possible more relevant learning

5 Mager, Robert Preparing Instructional Objectives, Fearon: 1963

experiences for individuals by providing materials of different levels of difficulty and for different interests.

Process Variables

The process variables will define the types fo learning activities, media, grouping patterns, teaching stratagies etc. which may be used with the learning content to achieve a specific behavioral objective. In identifying process variables, an effort will be made to provide alternatives at the various levels of abstraction (see Dale's cone of experiences)[6] so that the instructional program is more likely to make contact with the individual student.



Cone of Experiences

In constructing curriculum modules, care must be taken to insure internal consistency. That is, if the objective deals with an inductive approach to learning, the content and process variables must provide for this kind of learning to take place.

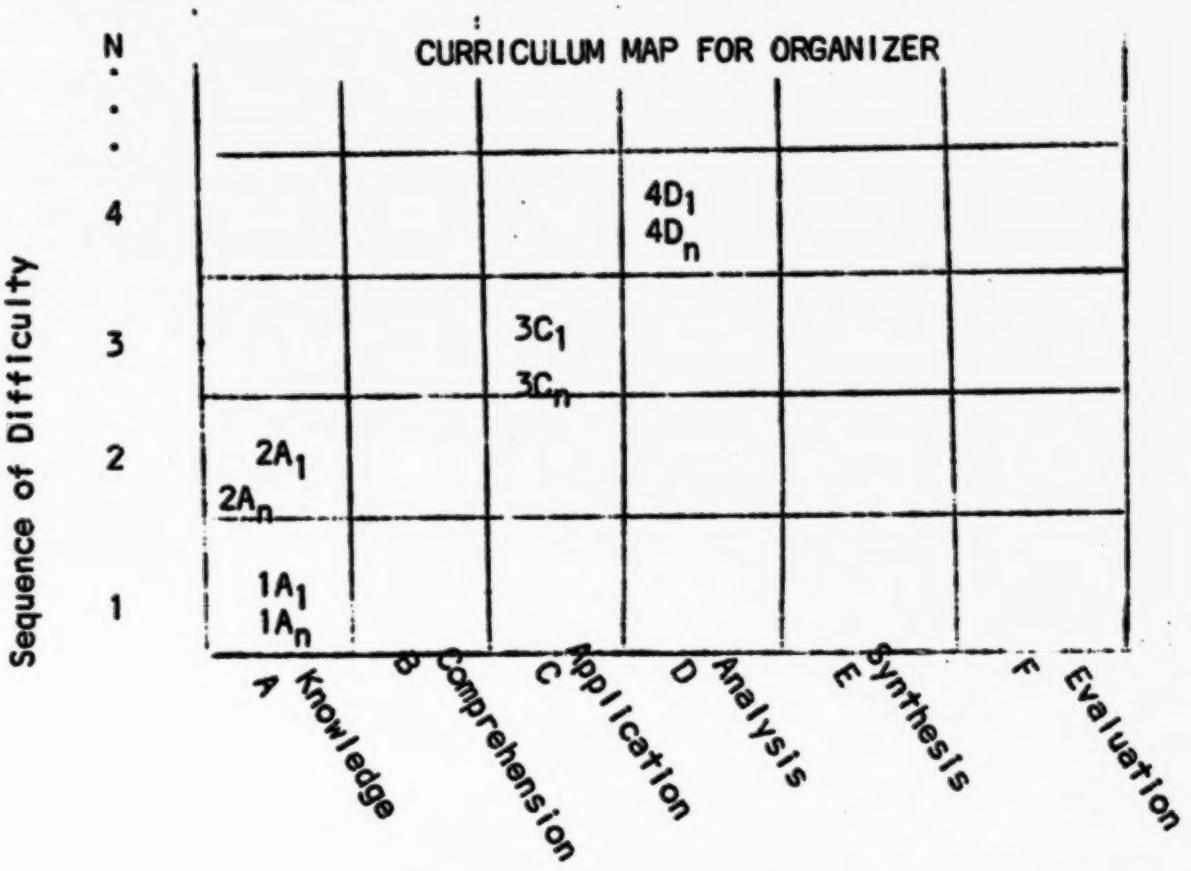
6 Dale, Edgar Audio Visual Methods in Teaching, Dryden Press

Curriculum Map

The curriculum modules relating to each organizer will be filed on a three dimensional curriculum map. A map will be constructed for each organizer. The "objective" of the module will determine its location on the map. The vertical dimension of the map will be the sequence of difficulty and the horizontal dimension the depth or level of learning.[7] Modules containing alternate learning content and learning process for each cell will be accomodated by the third dimension.

Each curriculum module will be identified by a number, a letter, and a subscript. The number and letter (3C) will locate the module on the vertical and horizontal dimension of the map. The subscript $3C_2$ will identify the content and process components of that module.

An attempt will be made to construct modules which will enable students to pursue learning activities at each of the various levels of learning as they move up through the vertical sequence.



8 Bloom, Benjamin Taxonomy of Educational Objectives, McKay: 1956

THE TEACHING-LEARNING CYCLE

Instructional Decisions

There are two levels of decisions which must be made if we are to provide a better match between the individual learner and his learning environment. The first level of decision is concerned with the selection of behavioral objectives for an individual learner at any point in time, objectives which are relevant for the child based on his own capabilities and level of development.

The second level of decision is related to the selection of the learning content and the learning process which will best facilitate the acquisition of the specific behaviors as described by the objective.

The Teaching-Learning Cycle

The curriculum modules will provide the information about the teaching-learning alternatives for the above decisions. The teaching-learning cycle will provide the framework within which these decisions can be made and implemented.

As indicated earlier the teaching-learning cycle is tied to the SYSTEM ORGANIZER of expected outcomes and includes the following steps:

1. Analysis of the learner's performance characteristics in relationship to the expected outcomes.
2. Decisions concerning the specific objectives for the learner in light of this analysis.
3. Analysis of the learner characteristics to determine appropriate learning content, and learning process.
4. Decisions concerning the structure of T-L environment.
5. The T-L activity - the individual learner interacting with the learning environment.

6. Evaluation of the outcomes of the process in terms of learner performance.
7. Decision concerning adequacy of learner performance as compared to the behavior described in the specific objective.

SYSTEM OF THE INDIVIDUAL LEARNER

The system of the individual learner will contain the specific characteristics of the individual which will assist in the making of the decision described in the previous section.

Student Information for Selecting Behavioral Objectives:

The selection of behavioral objectives in a performance based system for individual students will be much more precise than in a traditional system and it should also be much easier once the system is established and operating. This will be particularly true where the objectives are highly sequential.

To begin the operation some fairly specific diagnostic tests will be needed to help identify where each student should enter on the curriculum map. Errors made in the placement of students on the map should not cause serious problems since other alternatives will exist and the child can be moved up or down, to the right or left, until an apparent match in student ability and objectives is reached.

In addition to diagnostic tests, records of students past performance, and teacher judgement will be of most assistance in placing the student in the instructional sequence.

Student Information in Selection of Content and Process Variables

Information concerning the individual students reading level, interests, and concerns will provide the initial basis for selecting the learning content variables.

The process variables will be based on information about the student's learning style and his ability to deal with various levels of abstraction. A history of the types of experiences engaged in by the individual student will be helpful in determining at which level of the experience cone he can best operate. This in turn will suggest the media and other mediating conditions to which the student can best relate.

THE SYSTEMS MODEL AND THE COMPUTER

The requirement which the use of a computer imposes on a system for breaking down the information into its smallest component parts will provide the opportunity to gain new insights into the teaching-learning process. The capability of the computer to handle many variable can assist in the analysis of the interaction of these variables and will provide the opportunity for a <u>systematic</u> refinement of the instructional program.

<u>The Evolving Role of the Computer</u>

In the early stages of the development of the project, the computer will be used primarily for the retrieval of information from two data-files. The first file will be made up of the curriculum modules of the T-L environment. The structure of this file will be determined by the curriculum maps, each of which is built around a system organizer.

The second data-file will contain information about the specific characteristics of the individual student. It is this information which will assist in the making of the decisions as described on page 26

As teachers use these two data-files for making instructional decisions, a record will be kept of the "matches" made between the curriculum modules and the characteristics of the individual learner. At the end of each T-L cycle, a judgement will be made concerning the adequacy of the "match" in terms of the individual learner acquiring

the desired behavior as described by the objective.

If the "match" is a good one, that is the individual acquired the specific behavior, a record of this "match" will be stored in the computer. The computer will then build up a repertoire of good "matches" between individual learner characteristics and curriculum modules.

It is this constant feedback of information concerning the appropriateness of curriculum modules for specific learner characteristics that will keep the system in a state of dynamic balance.

As this repertoire of appropriate matches between T-L alternatives and learner variables is built up, instructional decisions will no longer be based on only one teacher's best judgment, but will be based on a composite of the best professional judgment of all of the teachers who have used the system.

Thus, a system which starts out primarily as a data-file will soon become a powerful tool to <u>assist</u> in making instructional decisions.

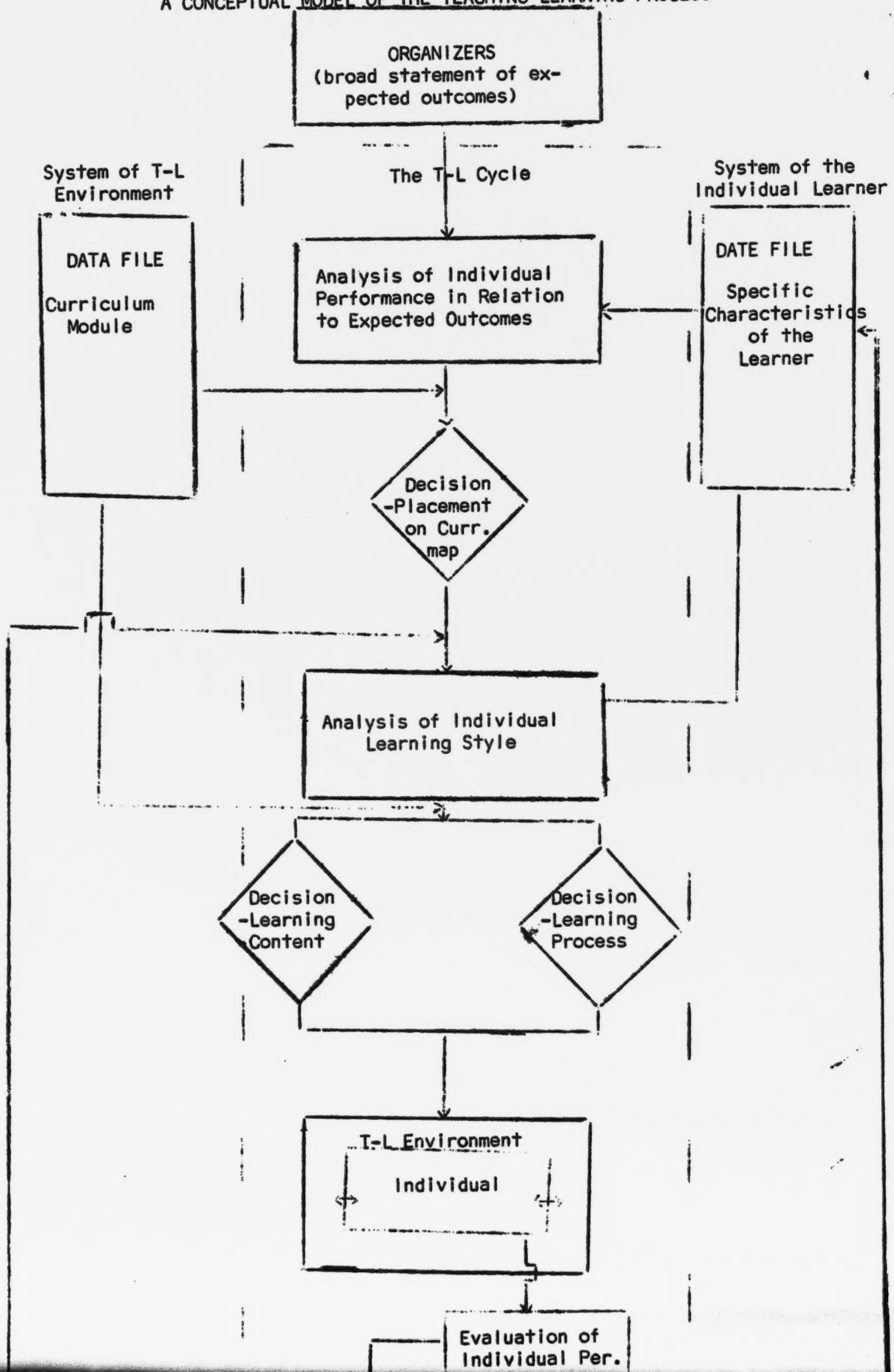
<u>Teacher - Computer Dialogue</u>

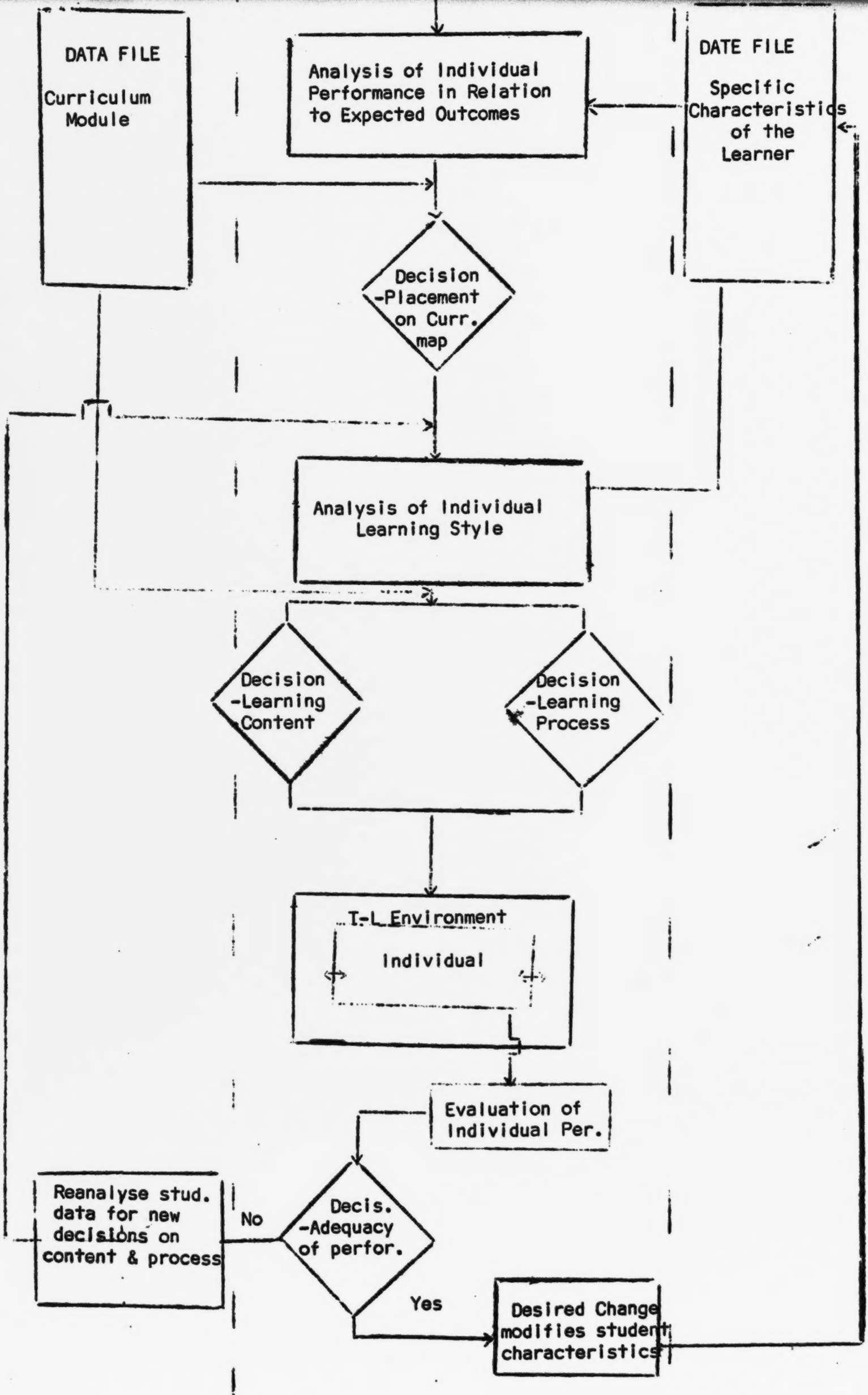
The focus of this project is the individual student, and the attempt to tailor instructional programs to individual needs. It is from this perspective that the dialogue will take place between the teacher and the computer. This dialogue will provide the teacher with information about (1) the student's progress and capabilities which will assist in the selection of specific objectives, and (2) his interests, reading level and style of learning which would suggest the best learning content and learning procedures to be used. Dialogue capabilities must also be present to allow for the easy updating of student information.

Although the individual learner will provide the focus for the computer-teacher dialogue, this does not mean that all instruction will be on a tutorial basis. In any group of students there is the possibility

that more than one student is ready to be involved in a given learning situation. The computer will be programmed in such a way that the teacher is kept aware of the progress of the students and can group for economy and efficiency where it does not conflict with individual student progress.

A CONCEPTUAL MODEL OF THE TEACHING-LEARNING PROCESS




DATA FILE
Curriculum Module
Analysis of Individual Performance in Relation to Expected Outcomes
DATE FILE
Specific Characteristics of the Learner
Decision -Placement on Curr. map
Analysis of Individual Learning Style
Decision -Learning Content
Decision -Learning Process
T-L Environment
Individual
Evaluation of Individual Per.
Reanalyse stud. data for new decisions on content & process
No
Decis. -Adequacy of perfor.
Yes
Desired Change modifies student characteristics

PROCEDURE

The system approach to the T-L process as described is a significant departure from the traditional approach to education. It not only will require the restructuring of the curriculum, but will require a significant change in the role of the teacher in the classroom.

The procedure for implementing this program will require a two pronged approach. One aspect of the project will be devoted to the restructuring of the curriculum which will serve as the basis for the "soft ware" of the system. The other aspect will deal with inservice work with participating teachers to develop the skills and understanding needed to operate in an individualized instruction program. Both aspects can and should take place simultaneously.

RESTRUCTURING THE CURRICULUM

The system model as developed can accomodate all existing types of curriculum, i.e., modern or traditional, skill development or concept development, inductive or deductive, content centered or child centered. The model itself is neutral as far as an educational philosophy is concerned. The kind of curriculum provided by the system will be determined by the way the "organizers" are defined and the structure of the supporting modules.

The first step in restructuring the curriculum will be the definition of "organizers" for the curriculum involved. Publications such as "Behavioral Goals of General Education in High School" will be used as the basis of this effort.[9] These organizers will provide the guidelines for the writing of the specific behavioral objectives. Once the objectives are written, materials and activities from existing

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9 French, Will Behavioral Goals of General Education in High School Russell Sage Foundation: 1957

curriculums can be selected to complete the individual modules. It is not the intent of the project to develop totally new curriculum materials, however where existing materials are not suitable new materials will need to be written. Every effort will be made to keep from using a 19th century curriculum in a 20th century system.

Curriculum Design Team: A team approach will be used to design the curriculum for the system. This team will include (1) top consultative assistance from outside the District in subject matter content, learning theory, and evaluation, (2) a full time person to develop the behavioral objectives (3) school district curriculum supervisors (4) classroom teachers (released 1/2 day/wk) to identify materials and activities for each behavioral objective. (The Title III Planning Grant, "A Cooperative Community Educational Resource Center" will dovetail with this project at this point)

This team approach will bring to bear the necessary expertise at the critical points of curriculum design. That is, consultative help will bring the knowledge and understanding needed to identify the organizers around which the learning experiences should be focused and the learning theory related to implementing these organizers. The person writing the objectives will not only be competent in the curriculum area, but have the writing skills to develop the behavioral objectives for the curriculum modules. The curriculum supervisors and the classroom teachers will bring the practical experiences needed to assist in the identification of materials and activities to implement the program in the classroom.

It will be the function then of this team to (1) define the "organizers" (2) develop the "curriculum modules" and (3) place the modules on a curriculum map for each organizer.

Guidelines to be used for the curriculum work are presented in:

"Instructional Systems Approach to Course Development"
Michael R. Eraut, University of Illinois

"Factors to Consider in Curriculum Design and Development: A Conceptual Framework" School District of University City, Missouri; January 1966

Preparing Instructional Objectives, Robert F. Mager, Fearon: 1962

Taxonomy of Educational Objectives, Handbook I, Benjamin S. Bloom McKay: 1956

Taxonomy of Educational Objectives, Handbook II, David R. Krathwohl McKay: 1956

Classroom Questions: What Kinds? Norris M. Sanders Harper and Row

Need for Materials: In implementing an individualized program of instruction it is commonly recognized that a greater variety and quantity of instructional materials are necessary. Experience in the Duluth Public Schools has indicated that it takes approximately $3,000.00 to equip a classroom adequately for such a program to operate. (This is the cost of moving from a traditional program to an individualized program and is not necessarily over and above the present expenditure of funds for equiping classrooms for present programs.)

In order to structure modules for a variety of learning activities which will accomodate students with different learning styles, new types of learning materials will need to be explored. It is for this purpose that a budget item has been included so that a full range of learning activities might be provided.

Curriculum Format: The curriculum modules developed by this team will initially be filed on McBee key sort cards. These cards will serve as a "hand computer" until enough of the program is developed to justify a computer based operation.

INSERVICE EDUCATION

The restructuring of the curriculum to make many instructional alternatives available is solving only part of the problem of moving to a system of individualized instruction. The accomodation of individual differences requires a major change in the teachers role in the classroom.

Role of the Teacher: Changing the pupil teacher ratio is not necessarily a criteria for implementing this system, however the responsibilities and activities of the teacher will be modified. Rather than being a presentor of information, the teacher will assume a role of consultant and/or director of learning activities, a diagnostician of individual student needs and a prescriber of learning alternatives. One who is responsible for insuring the meaningfulness of learning activities for individual students. This will involve the development of the ability to use student information from cumulative records as well as identifying clues in the daily contact with students for making individual assignments.[10] It will necessitate the recording of accurate information about student attainment and successful teaching strategies for individual students for his own future reference and to aid other teachers who are or will be working with the child.

Patterns of student contact will move from large group instruction for long periods of time on broad general topics to working with students singly or in small groups for shorter periods of time and concerned with specific problems, objectives, or concepts.

As this new role of the teacher evolves it is anticipated that a team approach to instruction will develop. This teaming will (1) allow for additional learning alternatives in terms of matching teaching style

10 Gordon, Ira J. Studying the Child in School John Wiley: 1965

to learning activities and student personality (2) provide differentiated teaching assignments geared to the strengths of individual teachers (3) relieve the teacher of clerical tasks by adding para professionals to the team.

Continuing inservice activities will be carried on by the project staff supported by consultative assistance to assist with the development of this new teacher role.

Identification of Critical Variables in the Individual Learner:

The attempt to create a system which will provide a better "match" between the learner and his teaching-learning environment is a "chicken and egg" situation. One cannot successfully identify good T-L alternatives without looking at the learner population to determine what T-L alternatives are needed. On the other hand it is not possible to make good decisions about instructional programs for individual students without some specific alternatives to select from. Both systems need to be dealt with simultaneously. As the alternatives become more clearly defined, the process of diagnosis will become more precise.

The kinds of information used in the diagnosis will not be limited to a single intelligence test or achievement test score but will include observational techniques and homemade measures to sample the child's level of development as it relates to the organizers of the system. As indicated earlier, one aspect of the inservice program will be to develop the ability to draw clues for instructional decisions from the daily contact with children.

The student information used in making instructional decisions will also be filed on McBee cards so that records can be kept on data used to make specific decisions about the T-L process.

Scope of Pilot Project:

It would not only be unwise but impossible to implement this program at all levels and in all curriculum areas at the same time. Fortunately the "building block" approach of the system will allow the program to be developed and implemented gradually.

Columbine Elementary School has been selected as the pilot school to work with the project. During the next year the language arts curriculum for grades K - 6 will be restructured and implemented in this school. This will involve 26 teachers, and 700 children for approximately 1/3 of their school day.

As previously indicated, the information needed to carry out this project will be handled initially on key sort cards. This information will be transferred to a computer program during the later part of the pilot project.

Upon the completion of this task, all of the major procedural aspects of the project will have been accomplished and it will then be ready for the operational phase.

Operational Phase:

It is anticipated that ESEA Title III will be asked to assist with the financial support of this project for a minimum of two years at the operational level. This will provide the additional financial resources to:

(1) restructure additional curriculum areas.

(2) expand the program to other elementary schools.

(3) begin moving the program into the junior high and high school levels of the district.

It is very difficult to estimate accurately the financial needs of this project a year and a half from now. A much more accurate figure will be available as the pilot phase of the project gets under way.

At this time it would appear that to develop the project at a reasonable rate, funds in the amount of $120,000 will be needed annually. As the task of restructuring the curriculum is completed and the majority of the teachers are operating in the system these costs will diminish appreciably.